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Body temperature of Arctic weasels:
higher or lower than other mammals?

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Running head: Body temperature of weasels

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ABSTRACT

Core body temperatures of male ermines were continuously monitored using implanted temperature transmitters. Mean T_b in the abdominal cavity for a 24 hour period were 38.4 and 38.8°C. Body temperature ranged from 37.9 to 40.6 in one individual and 37.5 to 39.7°C in the other. Body temperature of a male ermine during forced activity on a treadmill increased linearly with time and the rate of increase was related to metabolic rate. Small weasels have body temperatures slightly higher than those of other small mammals. Data from the present study are not consistent with body temperatures previously reported for small arctic weasels and the difference between data from our study and the other probably reflects a difference in technique of measurement. Data presented in this study and calculations based on heat transfer coefficients suggest that internal organ temperatures differ significantly from normal body temperatures within one minute after death.

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INTRODUCTION

In a recent study, Folk et. al. (1977) report a resting body temperature of 36.6°C for least weasels (Mustela rixosa). This value is relatively low compared with resting body temperatures of continuously endothermic small mammals (Morrison and Ryser, 1952). Moreover, other investigators report values for body temperature of small weasels as 39 to 39.5°C, slightly higher than those of other mammals of similar size (Brown and Lasiewski, 1972; Segal, 1974; Casey and Casey, 1979). Small weasels are extremely excitable animals and handling of the animal prior to measurement of T_b may result in elevated temperature due to strenuous activity. Therefore, body temperatures of undisturbed ermines (Mustela erminea) were measured in an attempt to reconcile the discrepancies in reported core temperatures of weasels.

MATERIALS AND METHODS

This study was performed during July 1978 at the Naval Arctic Research Laboratory, Barrow, Alaska. Two adult male ermines (Mustela erminea) trapped locally (see Casey and Casey, 1979), were housed in separate stainless steel cages 30 X 18 X 12 and were given cotton for nest material. The cages were placed in opposite corners of a small empty room at approximately 15°C under natural photoperiod.

Small temperature transmitters (2g; M13 - Minimitter Corp.) were inserted through a 1.5 - 2.0 cm ventral midline incision in the caudal abdomen. General anesthesia was induced and maintained with Ketaset^R Plus (a combination of Ketamine hydrochloride {100 mg/ml}, prozamine hydrochloride {7.5 mg/ml}, and amino pentamide hydrogen sulfate {0.06-25 mg/ml}: Bristol Laboratories, Syracuse, N.Y.). Induction dose was 0.035 - 0.045 ml/100g body mass,

administered intramuscularly. One or two maintenance doses of 0.01 ml/100g body mass were needed over a period of 40 minutes.

The animals were returned to their cages and allowed five days to recover from surgery before systematic temperature measurements were recorded. During this recovery period body temperatures were obtained periodically and these did not differ from those obtained during the experimental period.

The transmitters (temperature coefficient = 10 pulses/ $^{\circ}\text{C}$) were initially calibrated in my laboratory and recalibrated two weeks later in Barrow within 24 hours of implantation. Calibration curves in the two instances did not differ significantly. Signals from the transmitters were picked up by loop antennae placed beneath the cages and attached to two A.M. radios. Output from the radios were connected to the input terminals of an AKAI A600 stereo reel to reel tape recorder. The tap recorder was located in a different room to reduce the disturbance to the animals when tape were changed (\approx 6 hour intervals). Volume levels on the two channels differed so that the signals from different animals could be readily distinguished. For data reduction, the output from the tape recorder was attached to a Grass polygraph and data were counted at 10 to 15 minute intervals.

The effect of increased heat production on body temperature was determined by forcing a weasel to run on a treadmill at 1.17 Km per hour. The treadmill was enclosed by a wooden and plexiglass chamber. Air was drawn through the chamber at a rate of four liters per minute. After water vapor was absorbed, a portion of the air was drawn into a Beckman Infra-red CO_2 gas analyzer. The analyzer was calibrated before and after measurements using outside air and two primary standard grade gas mixtures. Heat production was calculated from CO_2 consumption data assuming glycogen was utilized ($\text{RQ} = 1$) as fuel.

Body temperatures obtained from the implanted transmitter were continuously monitored during and after bouts of activity on a Grass polygraph.

RESULTS AND DISCUSSION

Core body temperatures of the ermines varied from 37.5 to 39.7 in one case and from 37.9 to 40.1°C over a 24 hour period (fig. 1). Mean body temperatures of the two individuals was 38.4 and 38.8°C obtained by averaging all data points for the 24 hour period.

There was no obvious cycling of body temperature in relation to an activity pattern. One ermine showed conspicuously elevated temperature for approximately six hours (fig. 1) while no such change was apparent in the other individual.

Although least weasels are substantially smaller than ermines, their body temperatures are of similar magnitude under similar conditions (table 1). Therefore, there is no a priori reason to assume that the results reported here for ermines are not also applicable to least weasels.

When the ermines were forced to be active for sustained periods, body temperatures increased. The highest body temperature measured in active ermines was 42.5°C. As shown in figure 2, body temperature rose steadily during enforced activity. The level of heat production never reached a steady state in these experiments because the animals were quite excited when enclosed in the treadmill. These data are probably well above the levels of metabolism necessary to run at 1.15Km per hour but they are useful in gauging the effects of metabolic heat production on the core body temperature. In both experiments the increase in body temperature was approximately linear with time. In the first case, (fig. 2A) mean CO_2 production for the 6.5 minute experiment was 7.86 ml CO_2 /g.h. (range = 6.50 - 9.15). The basal heat production of a 230g male ermine is 1.61 ml O_2 /g.h. (Casey and Casey, 1979). Assuming carbohydrate is the major fuel source (RQ = 1),

the ermines heat production was approximately 4.9 times BMR. Body temperature rose approximately 2°C during activity. There is a time lag associated with the actual change in core temperature and the time the transmitter responds. At the onset of activity body temperature remained constant for at least a minute and continued to increase at least a minute after activity was terminated. In the second experiment (figure 2B) using the same animal the average metabolic rate was only $6.13 \text{ ml CO}_2/\text{g.h.}$ (3.8 times BMR) and body temperature rose only about 1.7°C over an 8-minute period.

In view of the results in figure 2, I assume that the body temperatures obtained rectally (Casey and Casey, 1979; table 1) were not unduly high as a result of struggling by the animal prior to temperature measurement. Even if T_b increased at twice the rate measured here (fig. 2) as a result of struggling, the measurement was completed in under 30 seconds so that an increase of more than 0.2 to 0.3°C in core body temperature is unlikely. Moreover, once an ermine is grasped firmly around the rib cage struggling invariably ceases and they became quite relaxed.

Data reported by Folk et. al. (1977) for core body temperature of recently killed ^{weasels} may be lower than actual core temperatures for several reasons. First of all, least weasels have substantially higher thermal conductance (and, therefore, cooling rates at death) than other mammals. A 46g least weasel has a thermal conductance of $1.38 \text{ W/Kg}^{\circ}/^{\circ}\text{C}$ which is equivalent to a cooling rate of $.025^{\circ}\text{C}/\text{min}/^{\circ}\text{C}$. If the difference between the body temperature and ambient temperature is 20°C , in one minute core body temperature will be 0.5°C cooler. For a 25g weasel the drop in temperature is about 0.75°C . Moreover, decapitation and exsanguination have a direct effect upon the body temperature immediately after death primarily as a result of evaporation.

In summary, data for mean T_b of least weasels reported by Folk et. al., 1977 appear to be abnormally low due to the technique of measurement. Other studies of body temperature of small mustelids (Brown and Lasiewski, 1972; Segal, 1975; Casey and Casey, 1979) yield values which fall within the normal range of core body temperature report in the present study (fig. 1). It is reasonable to suppose that animals in respirometers are highly alert even while at rest. Therefore, "sleeping temperature" (see Folk et. al., 1977) may be slightly lower (approximately 38°C in the present study) than those measured for animals taken from respirometers. In view of recent studies showing a marked lability of body temperature in small continuously endothermic mammals (see for example, Morhardt, 1975), further studies on body temperature of mustelids are desirable.

Brown, J.H. and R.C. Lasiewski (1972). Metabolism of weasels: the cost of being long and thin. Ecology 53:939-943.

Casey, T.M. & K.K. Casey (1979). Thermoregulation of Arctic Weasels. Physiol. Zool. 52, 153-164.

Folk, G.E., Jr., M.A. Folk and D. Craighead (1977). A comparison of body temperatures of least weasels and wolverines. Comp. Biochem. Physiol. 58A, 229-234.

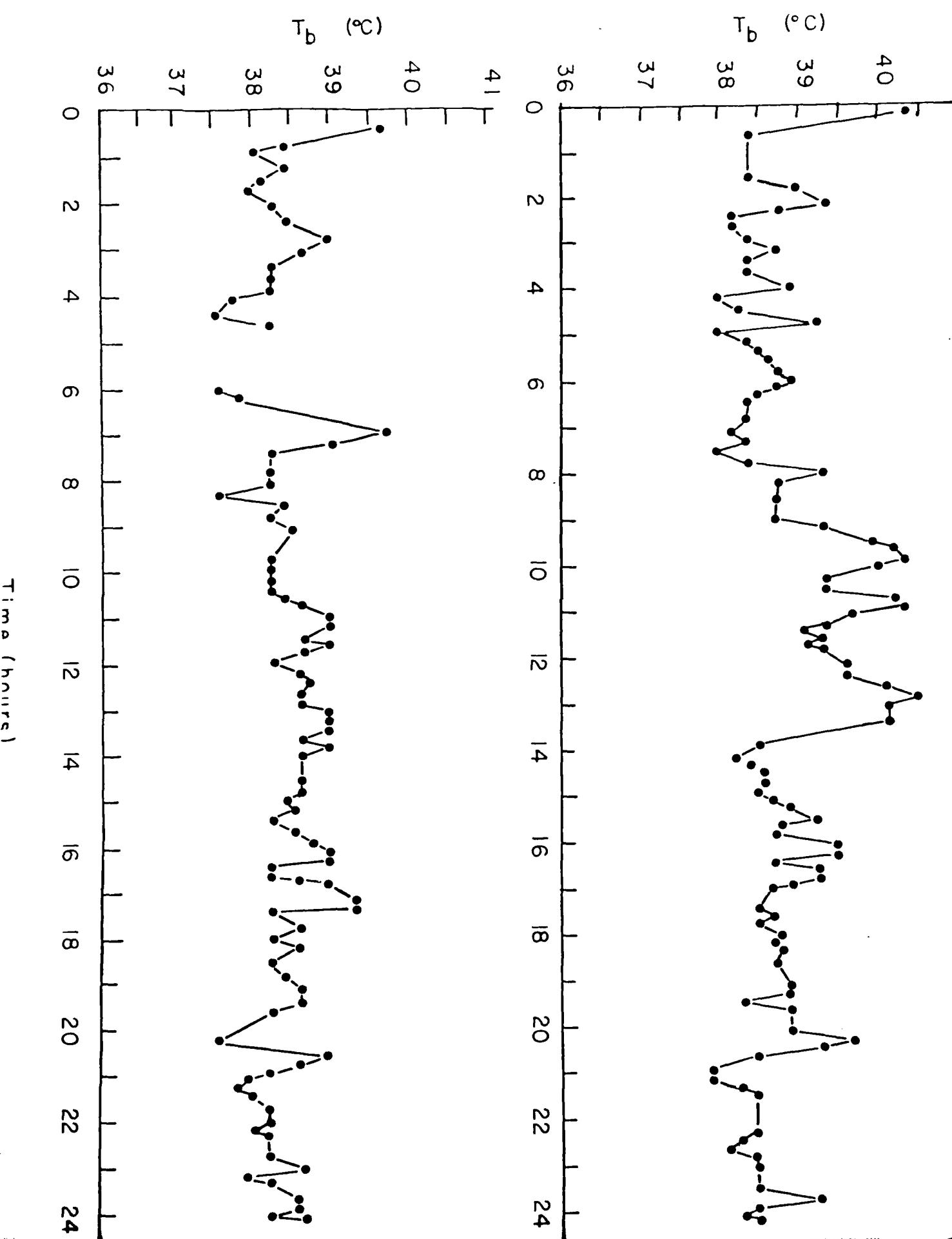
Morhardt, J.E. (1975). Preferred body temperatures of small birds and rodents: behavioral and physiological determinants of variable set points. In Perspectives of biophysical ecology (Eds. D.M. Gates and R.B. Schmerl) Springer-Verlag, New York.

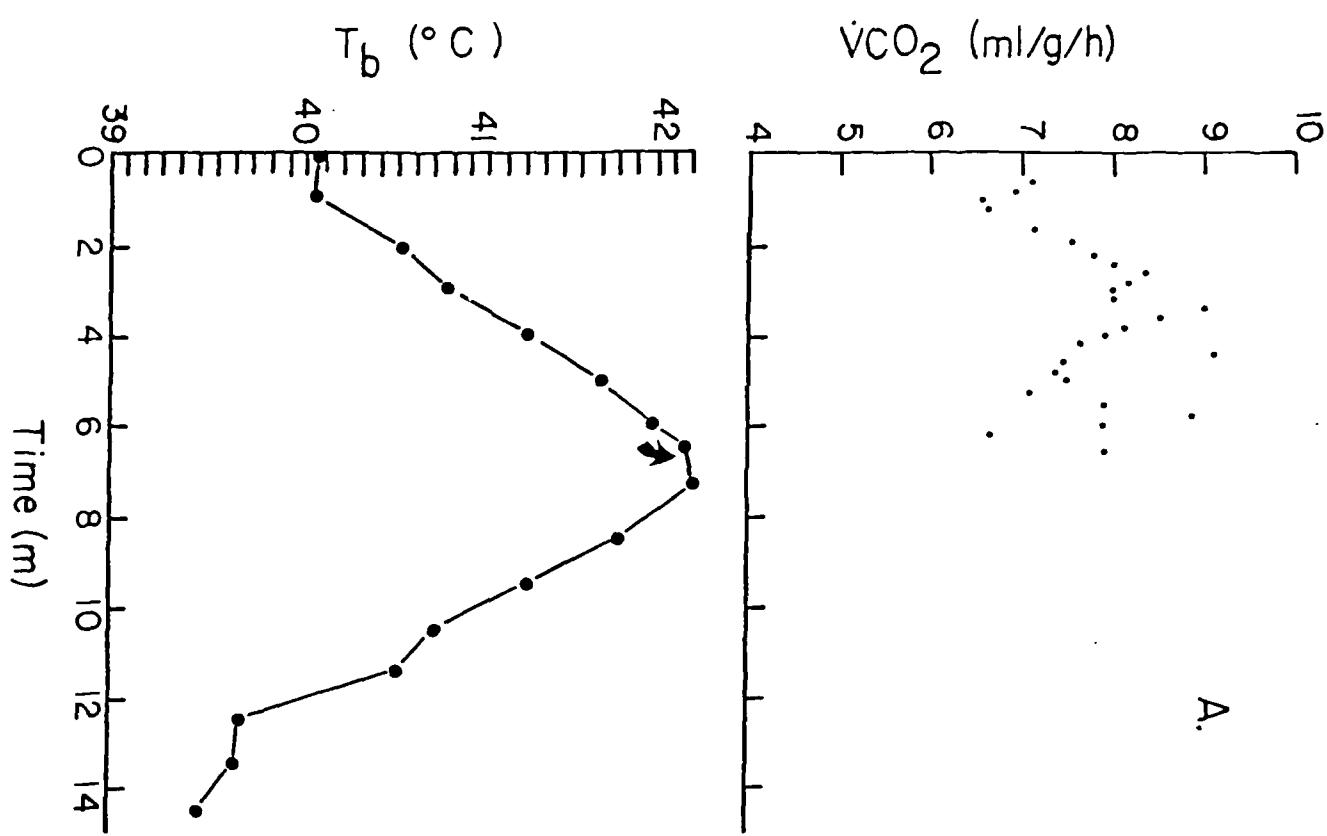
Segal, A.N. (1975). Postnatal growth, metabolism and thermoregulation in the stoat. Soviet J. Ecol. 6:28-32.

FIGURE LEGEND

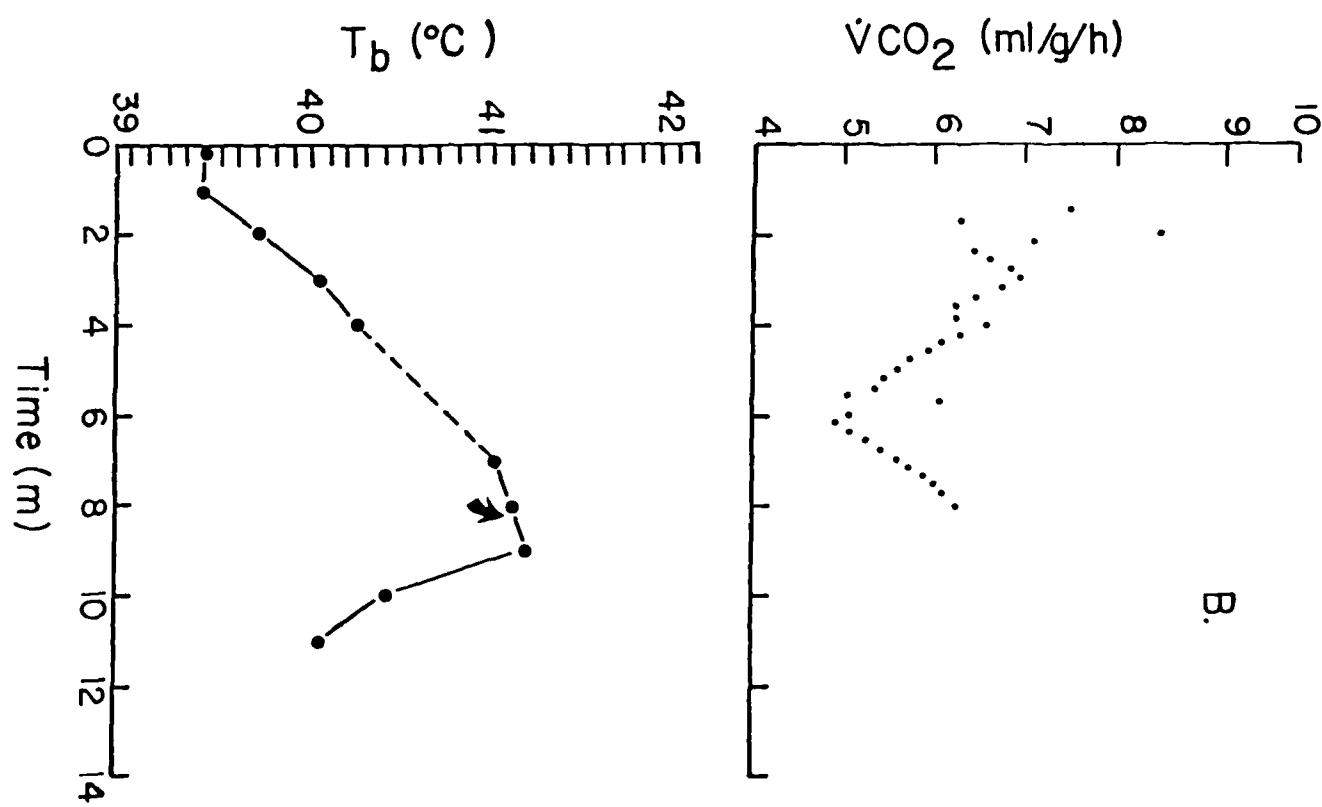
Figure 1. Core body temperature of two male ermines over a 24 hour period obtained from radio transmitters implanted in the body cavity.

Figure 2. Body temperature and carbon dioxide production of a male ermine during forced activity.





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